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SCARCITY OF *NYMPHALIS IO* AT PENDEEN (WEST CORNWALL) (LEP. RHOPALOCERA)

By Cpl. C. V. Adams, R.A.F., F.R.E.S.

I arrived at Pendeen on 6th July 1943, and immediately took account of the insect life in the locality and found *Nymphalis io* absent. This may have been due to early hibernation, but this was improbable as one fully-grown larva was found at a farm some ¼-mile from Portheras Cove on 15th September. This I kept and it pupated on 17th September, emerging as an imago (male) on 2nd October.

There appeared to be some definite reason for this shortage of *N. io*, and experiment would probably throw light on the matter, but because of my service duties, and the fact that I lived in a civilian billet, an experiment on a scale which would give an accurate or comprehensive picture could not be attempted.

In 1944 I decided to make an extensive search for *N. io* larvae and rear as many as possible. From January to July only fourteen were recorded after hibernation as follows :—

Date.	Number.	Locality.
15 March	1	Pendeen
24 March	1	Portheras Cove
25 March	4	Portheras Cove
7 April	1	Portheras Cove
17 April	3	Portheras Cove
29 April	1	Portheras Cove
3 May	3	Portheras Cove

The countryside area of selection was from St. Just to Morvah, a distance of three and a half miles, and from these two points direct to the sea.

After careful search, larvae were found on nettle clumps within twenty yards of the farm from which the single larva was taken the previous year, but not elsewhere. Four clusters of larvae were observed, on 19th June, totalling 713.

It would have been unsatisfactory to take the larvae then as it was necessary to ascertain whether they were attacked by Ichneumons, in which case an average could only be obtained by leaving them in their natural surroundings. Arrangements were therefore made with the landowner for the nettle to remain undisturbed until observations were completed. On 30th June a group of 130 larvae were taken from the site and housed in several containers. Although great care was taken, nevertheless deaths took place almost daily. The first pupation occurred on 4th July and pupation continued until 10th July. A count was then made and it revealed 46 pupae, 72 Ichneumon pupae lightly covered by soil, and 12 larvae which had died from other causes, giving 55·38 per cent. parasitic infestation with 10 per cent. deaths due to causes not known. Total loss 65·38 per cent. with a survival of 34·62 per cent.

Larvae left to natural elements were observed from time to time and it was seen that their numbers decreased alarmingly between each visit. This was not due to spreading, as such had been allowed for by extending the area

of nettle examined. On each occasion numerous larvae were in a shrivelled condition, either attached to the food-plant, or on the ground. Possibly a few had wandered away and pupated. Eventually only 10 remained, all of which were taken. Nine died the following day (parasitised), only one pupated.

Whilst awaiting further development of the pupae, 24 imagines were borrowed from a friend. These had been brought from Par (near St. Austell) as larvae. The insects were newly emerged and comprised 21 males and 3 females, and were to be liberated in Pendeen. The method of marking was that adopted by F. A. Urquhart (Ontario). A hole one-eighth of an inch in diameter was punched through the right fore-wing near the base and immediately behind the stout radial vein. A light-weight paper label three-sixteenths by seven-sixteenths of an inch was bent over the front margin of the wing and glued to itself through the hole. The label bore a number written in waterproof ink referring to records of date, time, sex, etc.

All 24 *N. io* were liberated at various times on 11th and 12th July, and all were seen to fly high without apparent hindrance from the labels.

Knowing that it would be impossible for me to observe the area unaided, I enlisted the help of 100 schoolboys and almost as many ladies of the local institute. Set specimens of *N. io* were given to aid identification and full instructions regarding the information I required.

In spite of the vast number of enthusiastic observers, only three recoveries were made, all of which were found at 10·00 D.B.S.T. on 12th July, settled on a privet tree not more than twenty yards from the point of liberation. The insects were males which had been set free at 22·00 hours the previous day. In view of their late liberation it was thought that they sought shelter in the tree but were recaptured before making good their escape. One other specimen was seen in Pendeen on 13th July, but this flew away before its number could be recorded.

On 17th July the first *N. io* emerged, and emergences continued until 23rd July, the main batch appearing on 19th. Four pupae died. These deaths were probably due to injuries sustained after falling from the pad at the larva–pupa change. A few imagines were imperfect and in some a variation of eye-spot occurred. Males were predominant and totalled 35, there being only 7 females. From these, 24 were selected, tagged (as described above) and liberated at Portheras Cove at 15·00 D.B.S.T. on 19th July. Only one was seen again, and that on 26th July, basking on a cabbage leaf in a garden about half a mile due east from the point of liberation. Here again the insect eluded capture and its number could not be taken. Its condition was good and its flight swift. The resultant imago survivals from 130 larvae was 42 (a cripple being counted as not surviving). This gave 66 per cent. deaths and 34 per cent. survival. Roughly one-third survived to the final stage.

July, whilst being the usual month for *N. io* to emerge, was unsatisfactory from the point of view of the weather, and, as far as could be gathered (from records), had been for three years previous and possibly longer. Fog gathers along the cliffs from Sennen to Gurnards Head and spreads inland to a depth of several miles. The fog frequently remains for a number of days during July and sometimes extends into August.

Meteorological reports were kept for every three-hour period throughout July, the average temperature for that month at 06·00, 12·00 and 18·00 hours D.B.S.T. was :—06·00 58·4° Fahrenheit; 12·00 64·6° Fahrenheit; 18·00 65·6°

Fahrenheit. The prevailing wind was westerly to south-westerly. Total duration of obscurity from January to July was :—

	Hours.	Minutes.		Hours.	Minutes.
January	100	30	May	10	00
February	56	50	June	48	15
March	24	50	July	98	10
April	61	45			

It will be noticed that, with the exception of January, July had the greatest period of total obscurity. In view of these rather freak climatic conditions it was thought that possibly the imaginal survivals were reduced after emergence by dampness. It was decided to carry out a second experiment, using *Aglais urticae* as a means of tabulating the effect of climatic conditions.

Between 1st and 7th August 110 imagines were numbered and released in Pendeen. The method of marking was revised, as the punch available was not suitable for *A. urticae*. Secondly, it was necessary for the non-entomological observers to be able to spot a marked insect rapidly without a close study of every one they saw.

The method adopted was that described by T. B. Fletcher (1936, *Ent. Rec.* **48** : 105–6). F. A. Urquhart (Ontario) mentions this method as unsatisfactory, but in my case it proved most successful. A large patch on the upper surface of the right fore-wing was rubbed clear of scales and a label three-sixteenths by three-sixteenths of an inch was attached. This label was made from semi-transparent paper, the adhesive, seccotine, being placed on the wing and the label pressed on to it. Clearing a large area of scales helped to distinguish between tagged and untagged insects.

The returns of recaptured *A. urticae* were far beyond expectation. Sixteen were actually taken (and released again at the point of capture); a further six were seen but the insects flew away before their numbers could be taken; a total of twenty-two.

TABLE 1.

Liberation of *Aglais urticae* in Pendeen.

Date	Time	Sex	No.	Retaken	Time	Direction	Distance	Total days
2.viii.44	13·00	M	12	14.viii.44	10·00	West	250 yards	12
2.viii.44	13·00	F	14	8.viii.44	11·00	West	200 yards	6
2.viii.44	13·00	F	17	8.viii.44	11·00	West	200 yards	6
2.viii.44	13·00	M	18	7.viii.44	14·30	East	10 yards	5
2.viii.44	13·00	M	19	8.viii.44	11·20	West	200 yards	6
3.viii.44	14·45	M	22	8.viii.44	12·30	West	100 yards	5
3.viii.44	14·50	M	24	14.viii.44	17·30	West	200 yards	11
4.viii.44	13·00	M	27	7.viii.44	20·15	East	20 yards	3
5.viii.44	10·30	F	31	8.viii.44	11·25	West	200 yards	3
5.viii.44	10·30	F	33	7.viii.44	11·30	West	200 yards	2
				8.viii.44	12·25	West	100 yards	3
5.viii.44	10·30	F	34	13.viii.44	13·05	W.N.West	220 yards	8
5.viii.44	10·45	F	37	8.viii.44	11·00	West	200 yards	3
				12.viii.44	19·30	West	Same place	7
5.viii.44	11·30	M	56	11.viii.44	18·50	West	200 yards	6
6.viii.44	16·00	M	73	14.viii.44	18·20	N.N.West	200 yards	8
6.viii.44	17·00	F	86	11.viii.44	16·45	East	10 yards	5
6.viii.44	17·00	M	93	13.viii.44	11·20	S.East	500 yards	7

Table 1 has been compiled from documents kept at the time of the experiment. It bears only the details of *A. urticae* which were retaken. The greatest proved period of liberty was twelve days (Insect No. 12), but Insect No. 22 was seen a second time 1000 yards south-east from the point of liberation during the week 20th–26th August, exact date and time were not noted by the observer but even so it is estimated that seventeen days would be the minimum interval from liberation to second sighting.

A large-scale drawing of the area was kept, upon which each insect observed was recorded. From the resultant plot it appeared that there was no definite movement in any one direction. The main recaptures were made in a garden 200 yards west from the point of liberation. Several had moved in an easterly direction, and one was recorded 500 yards south-easterly. It is interesting to note, however, that almost all recaptures were made whilst the insects were feeding upon *Escallonia rubro.*

Fortunately the fog period extended into August. 106 hours 10 minutes total obscurity were recorded between 3rd and 11th August. The average temperature from 1st to 14th was :—06·00 63° Fahrenheit; 12·00 69·3° Fahrenheit; 18·00 70·2° Fahrenheit; resulting in an increase of five degrees over the previous month with eight hours increase of fog (for the portion of August taken).

The main factor, therefore, appears certain. If *N. io* were liberated and remained within the area of liberation, climatic conditions would not interfere with the possibility of survival to hibernation. On the other hand, if *N. io* has a tendency to movement after emergence, the general direction would most probably be northerly with, possibly, a few remaining in the area. This may be so, and the lack of reports and recaptures tend to substantiate that view.

However, I am more inclined to the view that the western tip of Cornwall is not suitable to *N. io* to any great extent. The insect is highly subject to attack by Ichneumon, so much so that, under purely natural conditions, the survival rate would most probably be far less than 34 per cent., thus giving a decrease in the number of imagines able to hibernate until the following year.

A HYBRID HERMAPHRODITE OF *GLOSSINA* (DIPTERA)

By F. L. Vanderplank.

(*Department of Tsetse Research, Tanganyika Territory.*)

The results of crossing male *G. swynnertoni* with female *G. morsitans* have already been described by Vanderplank (1944; 1945).

The progeny of one such cross is of particular interest, since on emergence it was found to have the appearances of both male and female.

The male hypopygium, usually prominent externally, was present but completely internal, and invisible externally; the two spiny pads [1] figured

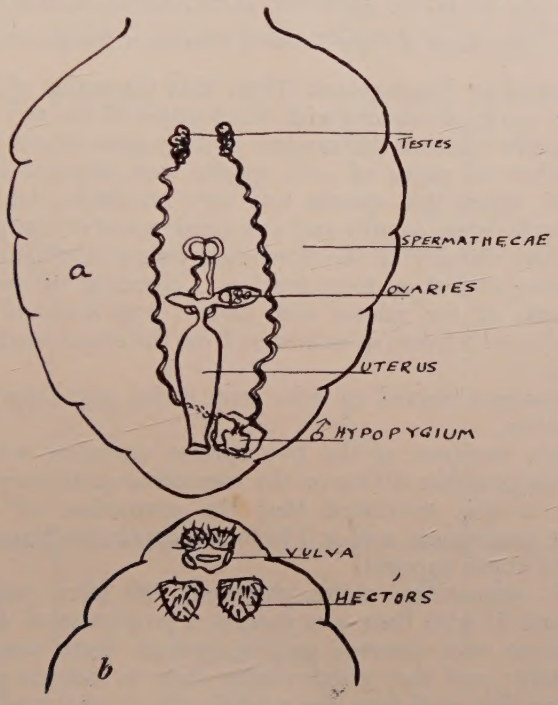

Fig. 1.—*a*. Internal structure, diagrammatic; *b*. External appearance.

by Newstead (1924) on the venter of the fifth abdominal segment were the only outward evidence of maleness. The visible external genital armature was that of a normal female. It was intended to keep the fly alive and try to mate it with a male *G. swynnertoni*—but unfortunately it died the following morning, whereupon I dissected it. It was found that the fly had a normal male reproductive system and testes, also a small but normally formed uterus, ovaries, and spermathecae as shown diagrammatically in the accompanying figure.

The male hypopygium was unfortunately too broken and mutilated during the process of extraction and mounting to allow it to be figured, but remains

[1] Hectors.

of the reduced superior claspers and of the juxta and harpes complex were recognisable.

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NEWSTEAD, R., 1924, *A Guide to the Study of Tsetse Flies.* London.
POTTS, W. H., 1944, *Nature* **154.**
VANDERPLANK, F. L., 1944, *Nature* **154**: 607–8.
——, 1945, unpublished MSS.

PAIRING OF *GLOSSINA MORSITANS* WESTWOOD WITH *G. SWYNNERTONI* AUSTEN (DIPTERA)

By C. H. N. JACKSON, D.Sc., Ph.D., F.R.E.S.

(*Department of Tsetse Research, Shinyanga, Tanganyika.*)

IT has been found by Vanderplank (1944) that the males of *G. morsitans* and *G. swynnertoni* mate at random with the females of the two species. It was important to know whether this random mating occurred also in the field.

Large numbers of pupae of both species were exposed in the habitat of *G. swynnertoni*, where that species was very numerous, for about ten days. Copulating couples were caught and examined, some of the pairs being taken in the immediate vicinity of the Stevenson screen in which the pupae were placed, and some at rest on trees nearby. Collecting was confined to within about 100 yards of the release site, and it was assumed that all young *G. swynnertoni* females taken *in coitu* were from the experimental pupae and not from wild ones.

All the females observed *in coitu* were unfed and teneral, that is, with unhardened chitin.

The relative numbers of the two species emerging were estimated by periodically counting flies sitting on the respective containers after emergence. In this way it was estimated that the proportion of *G. morsitans* to *G. swynnertoni* emergences was as 5·24 to 1, a conclusion broadly supported by the numbers of pupae exposed.

Of 360 *G. swynnertoni* males observed, 299 were paired with female *G. morsitans* and 61 with their own species, a proportion of 4·90 to 1. Fewer male *G. morsitans* were observed pairing, because there was, of course, none present originally, and they require some days to become potent, by which time most have dispersed from the neighbourhood of the release site. Of 48 male *G. morsitans*, 41 were paired with their own species and 7 with female *G. swynnertoni*, a proportion of 5·86 to 1.

Both of these ratios being extremely close to expectation, it is concluded that the males of *G. swynnertoni* mate at random with the females of the two species, and that the males of *G. morsitans* probably do so too, but the numbers are too small to show this last conclusively.

In view of Vanderplank's finding that the heterogamous matings are either barren or produce very few offspring, it is remarkable that neither species apparently has any defensive reaction against mating with the other.

REFERENCE.

VANDERPLANK, F. L., 1944, *Nature* **154**: 607–8.

TWO SPECIES OF *COLIAS* MIGRATING IN CENTRAL U.S.A. (LEP. RHOPALOCERA)

By K. J. Fisher (Mrs. Richardson).

On the 9th September 1944, in the rolling country about Lincoln, Nebraska, an apparent westerly movement of two species of *Colias* was observed from a moving car; similar behaviour was seen in the suburbs on the following day, but on neither occasion was there opportunity to make proper counts.

On the 11th, a long excursion was made among the farmlands within a radius of 100 miles from Lincoln, to look at Soil Erosion projects, and opportunity was taken to make counts of the migrating butterflies whenever possible (figs. 1, a–d). The morning was grey and rather cold, but there were sunny

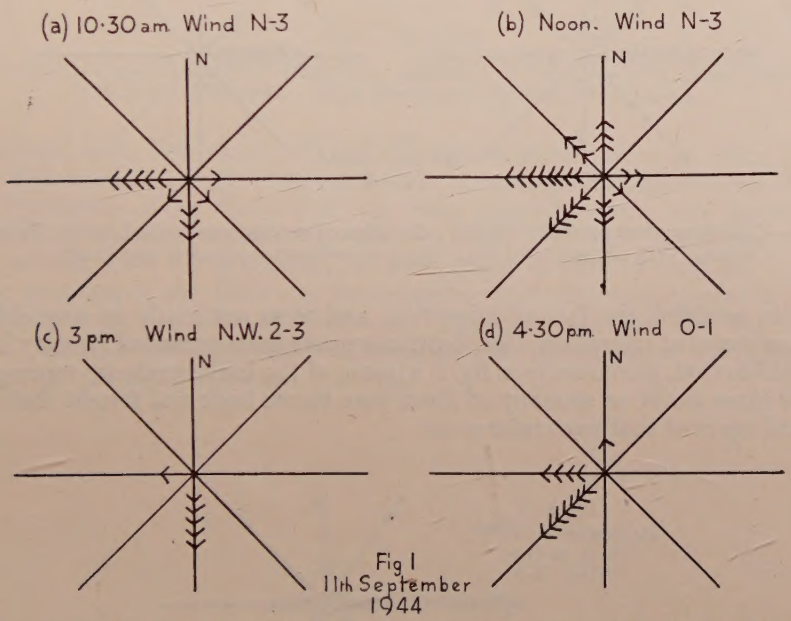

Fig. 1.—*Colias eurytheme* and *C. philodice*; direction of movements in the Lincoln, Nebraska, region, 11th September 1944. Each arrowhead represents one insect.

intervals later, with rain in the afternoon. Having no net, I was only able to get specimens by picking them out of the radiator of a car seen standing in the street; they proved to be *Colias eurytheme*; a second species, almost certainly *Colias philodice*, was also involved. The wind in the morning was fresh and cold from the N., force about 3, veering towards the W. in the afternoon, and dying away later. The butterflies flew fairly fast (6–8 m.p.h.?) but tended to linger over alfalfa fields and in sunny corners. The two species were about equal in numbers in the morning, but *C. philodice* became more numerous in the afternoon. It was difficult to distinguish between the latter and *Pieris rapae* near cabbage gardens. There was an apparent tendency for the line of flight to swing

S. as the wind moved from N. to N.W., and back again as the wind dropped; I think this effect is real, although I had no compass with me. But I took my directions from the line of the roads, which are said to run due E. and W. or N. and S.

Further counts were made in different places within the same region on the 12th (fig. 1, c and d). The morning was cool and grey with rain, but the weather cleared later with gleams of sun. The wind was more westerly than on the previous day, force 2–3, but with gusts strong enough to discommode butterflies in exposed flight. They mostly flew low over fields of alfalfa, and were apt to get blown back if they rose at all high. When this happened, they would soon drop down among the grasses and fight their way forward against the wind. This behaviour was watched several times. Counts were made in

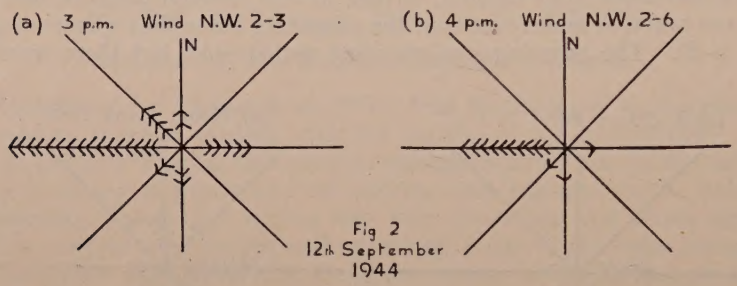

FIG. 2.—*Colias eurytheme* and *C. philodice*; direction of movements in the Lincoln, Nebraska, region, 12th September 1944. Each arrowhead represents one insect.

order to establish the fact of migration, and were not made on any definite front or recorded migration; the flight can never have exceeded Density I. It is probable that, particularly in fig. 2, a, some of the individuals are represented two or three times, as so many of them were blown back and fought their way forward again at that particular point.

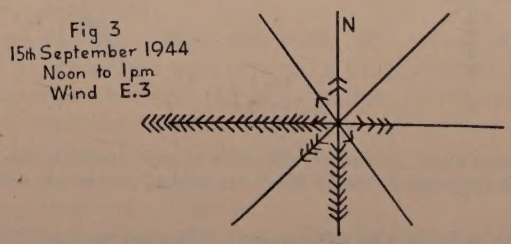

FIG. 3.—*Colias eurytheme* and *C. philodice*; direction of movements at Ames, Iowa, on 15th September 1944. Each arrowhead represents one insect.

On 14th September the migration was again noted at Ames, Iowa. On the 15th and 16th, counts were made and specimens taken in the grounds of the Agricultural College. Specimens of both *C. eurytheme* and *C. philodice* were taken, and also a hybrid between the two, which I was told had become increasingly common of late years.

The 15th was bright and sunny, but cold early; migration did not begin

until 11.30 a.m. At that time, *Colias* and *Pieris rapae* were feeding on dandelions with a good deal of random flight, but a strong drift to the west soon developed. At noon a count was made from a restaurant at a cross-roads (front, 50 yds.; time 60 minutes) and the movement was clear, see fig. 3. It was almost certain that *Pieris rapae* was accompanying the *Colias*, and as the two peaks at W. and S. developed, it seemed that the Whites were going one way, the Yellows the other. More careful examination showed that this was

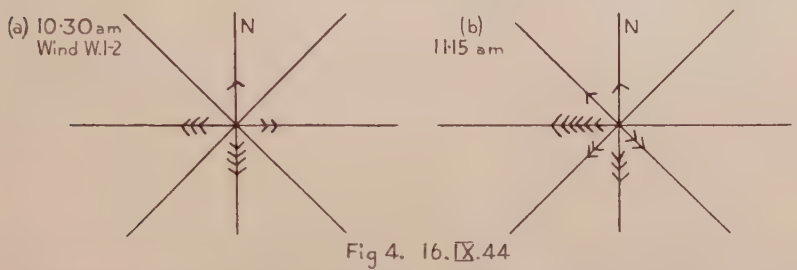

FIG. 4.—*Colias eurytheme* and *C. philodice*; direction of movements at Ames, Iowa, on 16th September 1944. Each arrowhead represents one insect.

not the case, both Yellows and Whites were definitely seen going in either direction. The existence of the cross-roads may have prejudiced individuals which would otherwise have flown S.W. I have noticed before how migrating butterflies will sometimes follow the line of a road. The wind was E. and quite strong at first, force 3–4 at a guess, but grew lighter as the day went on.

The morning of the 16th was much milder, and migration started a little earlier; fig. 4, a, was made at 10.30 a.m. The wind was from the W., about force 2. At 11.15 the 9th count was made. In the afternoon we left Ames for Chicago, and no more migration was seen.

FOUR BUTTERFLY MIGRATIONS IN INDIA AND CEYLON

By K. J. Fisher (Mrs. Richardson).

After six years in west and south-west China, where butterfly migrations are as sparse and difficult to observe as those in England, it was a pleasure to meet with mass movements in India and Ceylon.

Part of August, and all of September and October of 1943 I spent in northern India; although many species known to migrate were kept under observation, no movements were seen north of Hyderabad state. Later, in the south, three big migrations and one small movement were seen; the most important included nearly a dozen species, and lasted for at least three weeks.

(1) *Catopsilia pyranthe* L., Hyderabad, C. India (fig. 1).

Observations were made while travelling by train from Hyderabad City to Bangalore, on 3rd November, 1943.

About ten in the morning, soon after passing Mahbubnagar, small white butterflies were noticed rather commonly along the edge of the railway; they seemed to be drifting along in a south-easterly direction, and counts made from the moving train bore this out. When the train stopped at small stations, more careful counts were made and a compass direction taken; there was definitely a movement towards the south-east.

At Wanparti Road and for several stops thereafter, I got out on to the railway line and chased the butterflies with a net. They were flying fast, about 10 miles per hour, and always low, not more than three feet from the ground; they dodged rapidly and were not easy to catch. The train stopped for only a few minutes at each station, and hunting was frequently interrupted by hasty returns to the train for fear of being left behind. Finally, amid cheers from delighted fellow-passengers all along the train, who had naturally been much interested in my antics, I succeeded in catching two specimens, and returned breathless to my place. Later efforts, when the train made longer stops at more populated places in the Kistna Valley, met with no success.

The two caught are rather small specimens of *Catopsilia pyranthe* L.; one is 1·7 inch and the other 1·9 inch across. This rather dwarfish form made up the bulk of the flight, but there were also a few larger specimens with them, about two and a half inches across. The latter, however, flew much faster and rather higher, and proved impossible to catch.

After Wanparti Rd. Station, the butterflies became much more common. The train ran through dry country, with reddish gravelly soils, and all along beside the railway there were patches of yellow-flowered bushes, *Cassia auriculata* L., around which the Catopsilias were flying in clouds. It was difficult to see what they were doing on these plants. Some were doubtless feeding on the flowers, but some may have been ovipositing, as they were alighting more particularly on green plants, with the flowers in bud. In some cases large numbers, up to fifty or more, were whirling round individual plants, possibly in attendance on females; one pair were seen *in cop.* Over this area, where the butterflies were so numerous on the *Cassia* bushes, the south-easterly drift was not so obvious; the greater number were just flying round and round. The wind was light and changeable.

Between the Kistna River and Kurnool, the landscape changed to undulating plains, with black soil cultivated in great stretches of seedling wheat. Here the *Cassia* was uncommon, and the Catopsilias were flying almost due south-east, with very few flying in the opposite direction. The railway bore to the west at one point, and at a tiny station the butterflies had to fly over the train itself to keep on their line of flight. As they came across, one hundred were counted in a minute on a front of about fifty yards. This would be about Density IV on Williams' scale. After this, the numbers gradually thinned

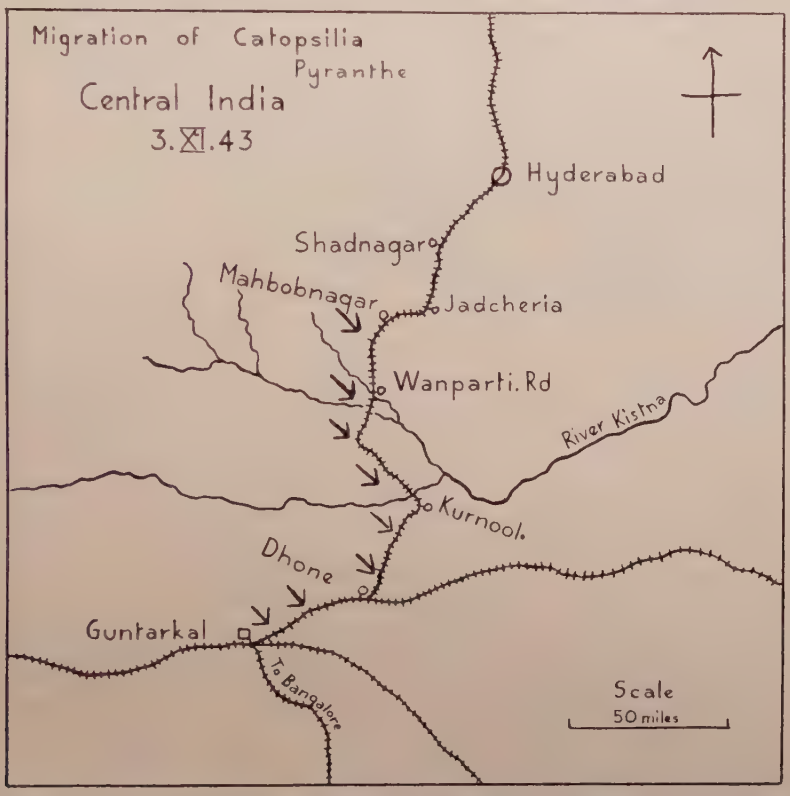

FIG. 1.—Map showing direction of migration of *Catopsilia pyranthe* in Central India, 3rd November 1943.

until Guntarkal, where only two or three were seen in the station, which was reached about 4.30 p.m. The train stopped at this junction until after dark, and no more migrants were seen.

Examination of the map shows that the butterflies were advancing on a front 75 or more miles wide; the migration was in evidence for about six hours, with a maximum density of 100 crossing fifty yards of platform in one minute; even though this density thinned off a good deal at the sides of the movement, many millions of individuals must have been involved.

(2) *Papilio hector* L., Adam's Bridge, S. India (fig. 2).

On 11th November we were travelling down the railway on the long narrow peninsula that stretches thirty miles or more eastwards from the Indian coast

and forms part of "Adam's Bridge". As the train made its way along the narrow neck of land, we passed many large *Papilio hector* L. that seemed to be migrating in the direction of Ceylon (E.S.E.). The butterflies were not numerous; only one or two dozen were seen in all, but their steady flight along the line of the railway was very noticeable, especially when the train stopped for customs examination. I was unable to take specimens, but am reasonably

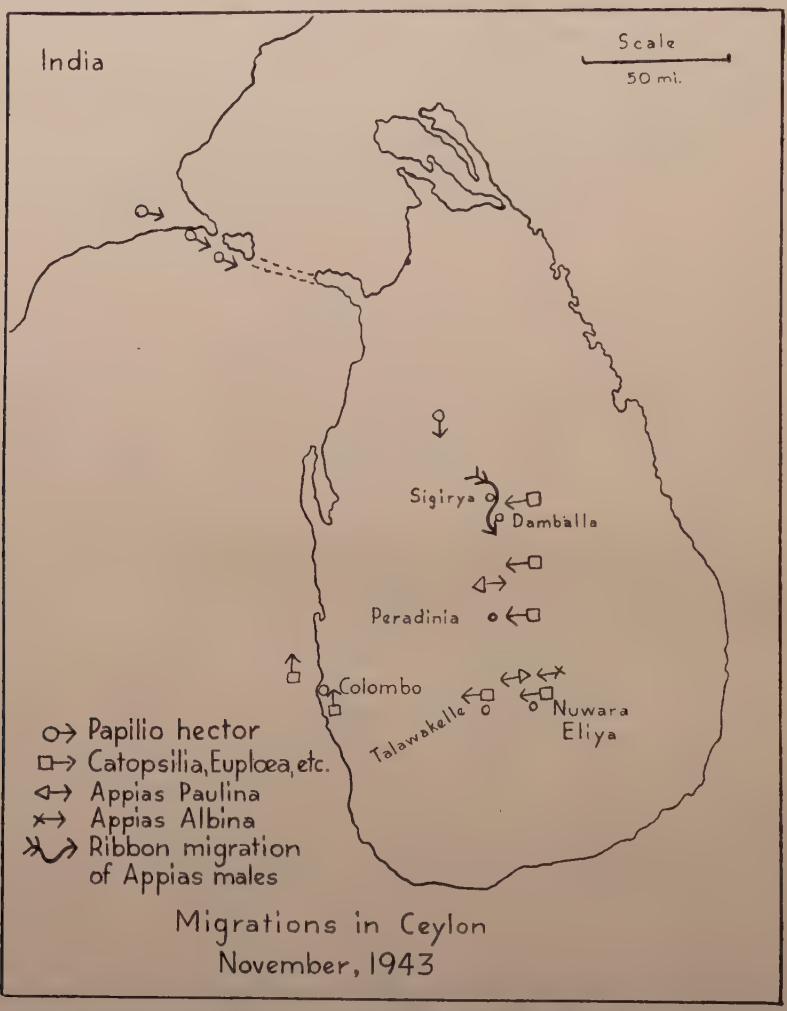

Fig. 2.—Map showing the direction of various migrations observed in Ceylon, November 1943.

sure of my identification. By the time the tip of the peninsula was reached, the weather had clouded over, with a cool onshore (easterly) breeze, and no more migrants were seen. It was dark when the sea crossing came to an end, on the Ceylon peninsula at Talaimanaar, and heavy rain was falling on the following morning. But one or two *Papilio hector* were seen later during fine intervals, still following the railway, here going southwards, well on the way to Colombo.

(3) *Catopsilia* spp. and others, Central Ceylon (fig. 2).

During a visit to the Tea Research Institute at St. Coombs, near Talawakelle, in the mountains of Central Ceylon, a migration was first seen at 11.20 a.m. on 20th November, and it continued until at least 8th December, when we left Ceylon. The movement was observed first in *Catopsilia pomona* F.; most of the migrants were males, flying W.S.W. in small groups, about a dozen individuals together at a time. The Density was between I and II, but was the more noticeable because of the bunching of the butterflies. By 3 p.m. the sky had clouded over, and no more migrants were seen until 10 o'clock next morning. This continued every day from about 10 a.m. until 2.30 or 3 p.m. By the 26th, the numbers had increased to fully Density II, the groups being larger, but still with intervals between them. On the 26th the butterflies also ceased flying about 3 p.m., although on this day it was still sunny at that time. They flew rather faster than a man can run, were dodgy and not easy to catch. Among the tea bushes they flew steadily, but in a garden they stopped to feed at flowers, always with the same air of being torn between migration and feeding that I have noticed before in migrating butterflies, especially in PIERIDAE. A few specimens that had been killed and laid on the grass seemed to attract the notice of others that came down to investigate. They made a convenient bait to bring fresh individuals within reach of the net.

During the earlier part of the week *Atella phalanta* Drury, *Euploea core* Cr. and other species were seen among the flowerbeds flying at random, and apparently taking no notice of the migrating *Catopsilia*, but by the 26th it appeared that the *Euploea* were beginning to join the movement. Close observation on the 27th showed this to be the case, and *Euploea core asela*, *E. coreta montana*, *Atella phalanta*, *C. crocale*, *Appias albina* and *A. paulina*, were all taking part in the flight. On the 28th, small numbers of blues were also joining in; *Nacaduba kurava prominens* Moore, and *Rapala manea schistacea* Moore were collected, and later kindly identified for me by Dr. A. S. Corbet of the British Museum. The flight direction varied very slightly during the week, between W.S.W. and W.N.W.; the wind, never strong, varied much more. The butterflies flew from ground level to eight or nine feet, the *Euploea* generally being among the highest ones.

On the 23rd, we drove to Nuwara Eliya, several miles to the east, and there saw several hundred *Catopsilia* streaming westwards across the golf course and along a valley; they seemed to be following the valley, although it took them slightly off their course, but they cut across the big windings of the motor road where it ran through a pass, and following it would have made them veer widely. The stream of butterflies, never apparently very wide, was picked up at intervals all the way back from Nuwara Eliya to Talawakelle.

The *Catopsilia* flew from 10 a.m. to 3 p.m.; on Sunday 28th, when several other species were flying, the Catopsilias disappeared at the usual time, but *Euploea*, *Appias* and the LYCAENIDAE continued until nearly 5 p.m. The absence of Catopsilias between the hours of three and five was very noticeable. On Monday morning, *Euploea* and *Appias* were already flying by 9.15 in small numbers; the Catopsilias started about ten as usual. This, and the fact that the other species were flying at random when the *Catopsilia* migration began, suggests that their presence in the migration was due to something stronger than a mere copying of the *Catopsilia*; one had more the impression of two or more migrations going on in the same direction.

At the beginning of the week, male *Catopsilia pomona* formed nine-tenths

of the flight; later, the proportion of females increased to one-third or more; on the 28th, in particular, a dozen or more of the handsome female variety *catilla* were seen. They were easy to distinguish on the wing.

Counts.

In the early part of the week counts were only made to assure the actual existence of migration; later, more careful counts were made to assess the proportion of other species in the flight.

26.xi.1943. *Catopsilia*, 7 ♀ and 17 ♂, 6 *Euploea*, 3 *Appias*, in four counts of a minute each on a front of 6–7 yards. Density II–III.

27.xi.1943. All species together. Density IV.

12 in 1 minute on 6–7 yds. front
18 in 1 minute on 6–7 yds. front
30 in 1 minute on 6–7 yds. front

28.xi.1943. (1) *Catopsilia* 52 ♀ and 93 ♂, *Appias* 3, *Atella* 9, and *Euploea* 8. 2 p.m. Total, 165 in 15 minutes on 6–7 yd. front. Density IV.
(2) 3 p.m. *Catopsilia* 106 ♂ 70 ♀, *Appias* 22, *Atella* 10, *Euploea* 16. Total, 224 in 15 mins. same front, Density IV.
(3) 4.50 p.m. *Catopsilia* 1 ♂ 2 ♀, *Appias* 2, *Euploea* 35, *Atella* 1, *Nacaduba* 9.
Total, 50 in 10 minutes. Density III–IV.

The fall in numbers of *Catopsilia* after 3 p.m. is very noticeable in the last count; while the *Catopsilia* have fallen away, the other species (even excluding *Nacaduba*, which has only just appeared) have continued to increase in numbers.

We left Talawakelle on 1st December; the weather was rainy on that day, and no migration was seen, but in Peradeniya on the 2nd and 3rd it was seen again. Some hundreds of *Catopsilia* were seen in the morning in the Botanical Gardens, moving almost due west. Rain fell in the afternoon, and migration ceased. The next day the movement was renewed, but the density was lower; *Euploea*, however, was particularly noticeable on this day.

On the 4th December we made a long journey to the north to visit Dambulla and Sigurya, about one hundred miles north of Kandy. Few butterflies were seen until approaching Dambulla, about 10.30 a.m., then *Catopsilia* and *Appias* were seen crossing the road in groups of five to ten. The butterflies seemed to be flying both ways, both east and west. Soon after this we stopped for an hour, and I was able to watch the behaviour of the butterflies in a strip of jungle between two cleared fields. It soon became obvious that *Catopsilia pomona* was migrating from east to west, and *Appias paulina* (both sexes) from west to east. *C. pomona* was flying higher, 5 to 10 feet from the ground, and most of them were rising to cross above the strip of jungle; there were more males than females. *A. paulina*, on the other hand, was flying low, skimming the ground, and was filtering in between the trees; males and females were in more or less equal numbers. *Euploea*, *Belenois* (?), *Papilio*, Satyridae and blues in large numbers were flying at random in the weedy fields.

About noon we left the Experimental Farm at Dambulla, and about three-quarters of a mile farther up the road we met with the *Appias* migration which will be described in the next section.

From Dambulla to Sigurya Rock the *Catopsilia* migration continued, the

butterflies always flying to the west. The famous Rock is a perpendicular crag about 400 feet in height; although it is only a hundred yards or so in diameter, *C. pomona* was several times seen flying up one side and down the other, instead of going round it. By three o'clock, when we turned to go back, the migration was thinning rapidly.

5.xii.1943. *Peradeniya.* At 10.30 the Catopsilias began to move as usual, and were flying westwards in small numbers. By noon, the migration had increased to enormous proportions; the butterflies were drifting down over the great trees in the Botanical Gardens like falling snowflakes. It was impossible to keep count of them. For two miles along the road from Peradeniya to Kandy there were constantly from 50 to 100 in sight at a time, and when we lunched in Kandy thousands of *C. pomona* and hundreds of *Euploea* streamed past the house for an hour. They were all gone by 2.30 p.m., when it clouded over, and rained for the rest of the afternoon.

The next day, in Colombo, it was fine; the *Catopsilia* were still in evidence. But they had changed the direction of their flight, and were migrating steadily northwards along the coast. None was seen coming in from the east, and I was unable to discover when the turning movement began. It was certainly more than a mile from the water's edge. This observation was repeated daily in various part of the town, on the 7th and 8th. In the town itself, in the grounds of the University, and in a suburb a mile or more inland, the butterflies continued their steady flight towards the north. The density was not great, between I and II perhaps, but there were always several in sight, except in the narrowest streets.

Going aboard ship in the afternoon of the 8th, a mile out in the harbour, we still saw a few Catopsilias flying north; perhaps twenty passed in an hour; at this point they were parallel with the coast.

(4) A Ribbon Migration of *Appias* males. Dambulla (fig. 2).

While watching the migration of *Catopsilia* and others described above, a separate migration of *Appias paulina* and *Appias albina* was encountered that seems so extraordinary as to be worth a separate description. Dambulla lies in the jungle on the plain north of the mountains; here the main north–south road runs fairly straight to Sigurya, some ten miles from Dambulla. Wind light and variable. Weather sunny. About three-quarters of a mile beyond the experimental station we met a column of *Appias* flying erratically down the road (southwards), sometimes following one another in single file, but more often in a dense band about a yard wide and high and about a foot from the ground. Nearly all were males, with an occasional female—one in a thousand or less. They were getting mixed up with the *C. pomona* migration, which was crossing their line of flight, and which sometimes would turn to accompany them for a few yards. The column zigzagged wildly from side to side of the road, and settled in groups of hundreds on patches of urine by the roadside. Where the road came to the edge of fields, they were settling in great numbers on freshly turned earth, and when disturbed, flew off to S.E. and S.W. Twenty-six insects were caught in one sweep of the net. Specimens taken included males of two species, *Appias paulina* and *A. albina*, with *paulina* predominating. (Determination kindly confirmed by Mr. A. G. Gabriel at the British Museum.)

The car ran north up the road through the jungle, and the *Appias* were seen all the way, sometimes following the road, sometimes cutting off bends by filtering through the jungle, in bands a thousand strong, with stragglers hastening

along between in single file. Around Sigurya Rock was more open space, and here the " ribbon " formation was abandoned, the butterflies being much less dense and more scattered, and their direction being more to the east than on the road.

By the time of the return journey from Sigurya to Dambulla the flight had thinned; but there were still large groups of *Appias* resting on the ground on the edge of the road. They flew up in clouds when the car disturbed them.

Ribbon migrations would not seem to fall easily into the classification of densities suggested by Williams (1942). The narrowest front suggested in Williams' table is 5 yards, and here the widest part of the ribbon was not above two. It is clearly improper to multiply the front by five; I would suggest that an attempt might be made to estimate the number of insects per yard of ribbon, and the length of ribbon. It was impossible to count, and difficult to estimate the numbers in this particular movement, but I would guess that there were seldom less than twenty, and often a hundred, insects per yard; at an average of fifty, say 88,000 per mile. The column was observed over ten miles; if they were moving for three hours at about 5 m.p.h., its length should have been about twenty-five miles, so the total number must have been of the order of two million.

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BIOLOGICAL NOTES ON *CHRYSOPA DORSALIS* BURM. (NEUROPTERA)

By Lt.-Col. F. C. Fraser, I.M.S. Retd., F.R.E.S.

Miss Alderson published a picturesque account of the life history of *Chrysopa dorsalis* Burm., in 1911. In that paper she expressed the opinion that larvae of individual species might be identified by the head-markings alone. In spite of this fact—and generally speaking, it is a fact—she dismissed the description of the head of *dorsalis* as—" *Characteristic markings* and *eyes* very dark brown, almost black, a dark line running through the eyes." Fortunately a figure of the head is given which shows two pairs of streaks which diverge anteriorly, and two streaks running medially from the sides of the head. As ar as can be made out, these markings do not tally very closely with an obscure photograph of the larva which also illustrates the paper.

In 1923, Withycombe published a revised description of the larva which, whilst it differed markedly from that of Miss Alderson's, was undoubtedly correct for the specimen from which he made it. Although it differs from most specimens which I have since had the opportunity of examining, this difference may be accounted for by the fact that a slight variation occurs in the markings of individual specimens. Withycombe remarked that, " If the head markings vary to the extent indicated by the two descriptions given, they are of little value for the determination of this species." It may be said at once, that the larva of *dorsalis* could be identified from Withycombe's description, although it would be quite impossible to do so from Miss Alderson's.

Withycombe stated that the larva recalled that of *C. perla* (L.) in the colour and markings of the body, but in build it is a little more slender. The length and breadth of larvae of Chrysopids is subject to great variation according to their attitude, being short and stout when at rest and slender and drawn out in periods of activity: thus no value can be placed on this doubtful character. As regards its similarity to the larva of *perla*, this is so close and the differences so indefinite, that I doubt if even long experience would enable anyone to separate them. This is understandable in the light of the close relationship existing between the two species and also in the close similarity of the adult insects.

I have to thank Mr. J. E. H. Roberts of Ottershaw for the opportunity of working out afresh the life-history of this interesting and beautiful insect. In the main I have found it to tally closely with Miss Alderson's account but differences in the time factors, that is the duration of the three instars etc., which I should imagine, however, are subject to wide variations depending partly on the atmospheric temperature, a high one favouring rapid growth as suggested by Miss Alderson, and partly on the amount of food available. I regard the latter as the most important, and since the larva in a state of nature must hunt for every aphid it devours, larval life must be generally longer than when in captivity where its dietary is brought to it. Mr. Roberts has found the species in moderate numbers during June and July on scotch pine in the neighbourhood of Ottershaw, Surrey, and confirms the statement made by Atmore, that the species can be distinguished from *perla* even when on the wing by its conspicuous darker colour; he makes no comment, however, on its more rapid flight. I have myself taken *dorsalis* on only one occasion and then mistook it for *perla*, Mr. Morton identifying it later as *dorsalis*. It appears to be restricted almost entirely to trees, especially pine trees and is thereby strongly contrasted with *perla* which is usually beaten from scrub, especially dwarf oaks and sloes. In the New Forest I have found *perla* to form very definite and restricted colonies, so that numbers could be beaten up at one spot whilst in others near by it was entirely absent.

The figure of *dorsalis* imago given by Atmore shows the head too pale, and the same may be said for that given by Killington, although to a lesser degree; the latter has been drawn evidently from a subadult specimen. Mr. Roberts' specimens, one of which I have figured, are fully adult and show the black markings to be much more extensive.

Two females were received from Mr. Roberts on the 5th July and were at once placed each in its own jar in which a sprig of scotch pine had been introduced on which they might lay their eggs. The insects were in good condition save that each had one wing more or less damaged: they were full of life and continued ceaselessly to explore their new habitat. On the 7th July one was found to have laid six ova, and this ultimately proved to be its first and last efforts at doing so. On the following day the second specimen had started work and from then on laid twenty-six eggs, which, with few exceptions, were deposited on pine needles, generally nearer to the apex than the base of these latter. The exceptions were probably accidental and due to the confined space in which the insects were kept; some eggs were attached to the glass sides of the vessels, others to adjacent pine-needles without the usual intervention of a stalk. The length of the silken stalks varied from 3 mm. to 7 mm.; each ovum was 0·8 mm. in length, bright pea-green at first but changing on the third day to a dull olivaceous colour. Ova laid on the 7th July hatched on the 16th and this period of 9 days appeared to be the

usual incubation period. The newly hatched larva sits precariously astride the empty egg-shell, its legs bunched together and curled under the egg, clasping it tightly. The head is bent down, gazing earthwards as if wondering how it is going to get down the slender stalk which supports its perch. Meanwhile the end of the abdomen is extended to an inordinate length and waves constantly like an elephant's trunk, and, with the aid of the suctorial pad at its end, goes carefully over every seta, the jaws and other mouth-parts. So much attention was given to the setae that I obtained the impression that it was straightening and combing these out in order to get them set correctly. This use of the anal-foot for cleansing purposes, vacuum-cleaner-like, is unique in my experience among insects. The young larva remains in this position for some hours and I noted at least one specimen which remained perched on the empty egg-shell for more than twenty-four hours. One of the first acts of the young larva, after descending from the egg, is to attack and eat neighbouring eggs, a fact which has been recorded by former authors and which doubtless sometimes occurs in nature especially in those species which deposit several eggs on a single stalk. For this reason, as soon as others hatched out, I removed them, each to its own test-tube, the latter being plugged with a pledget of wool in lieu of a cork; this afforded free aeration and proved to be a favourite resting-place for the larvae. The cleansing and supplying with food of so many test-tubes of isolated larvae was found to be very tedious but is essential on account of the cannibalistic habits of the larvae. Moreover it is impossible to estimate the number of ecdyses and length of instars of individual larvae if several be kept together. Larvae which had hatched on the 16th July changed to the 2nd instar on the 20th and to the 3rd and last instar on the 26th. The final instar, however, was greatly prolonged and the first larva did not spin up and enter the prepupal state until the 12th August, a period of some 17 days. Others were found to take an equally long period. As has been stated, most larvae preferred to rest on the wool plug, especially during each ecdysis; none was observed to suspend itself by the anal footpad for this purpose, as stated by Miss Alderson (nor have I ever observed this performance in any other species). Some larvae rested in the angle between pine-needles and twig, usually where these were the most dense and afforded the greatest measure of cover. In the case of one larva at least, I observed it reinforcing this hiding-place by pieces of the membranous bracts etc. at the foot of pine-needles. Occasionally when resting thus, the larva would raise itself on its legs, extend the end of the abdomen to a great length and wave it rhythmically from side to side; this would be continued for long spaces of time although the object for such an action was quite obscure.

For purposes of food, aphids from any source were given to the young larvae but only aphids from pine to those of the final instar. Newly hatched larvae were definitely scared of full-grown aphids and as soon as this was observed, only the smallest aphids were offered for food; apart from these matured aphids, all species were accepted and eaten greedily by the larvae. So great was the number of aphids consumed that the test-tubes rapidly became fouled and had to be cleaned out daily. This careful hygiene probably accounted for the very low mortality of 1, but a number of ova were lost in the beginning from the introduction, by oversight, of the larva of a *Coccinella*.

The newly hatched larva is translucent and colourless save for some pale markings on the head which diverge and tail away on to the prothorax (fig. 1, 2). The dorsal and subdorsal tubercles are proportionately larger and do not appear to grow at the same rate as the rest of the body; in the first

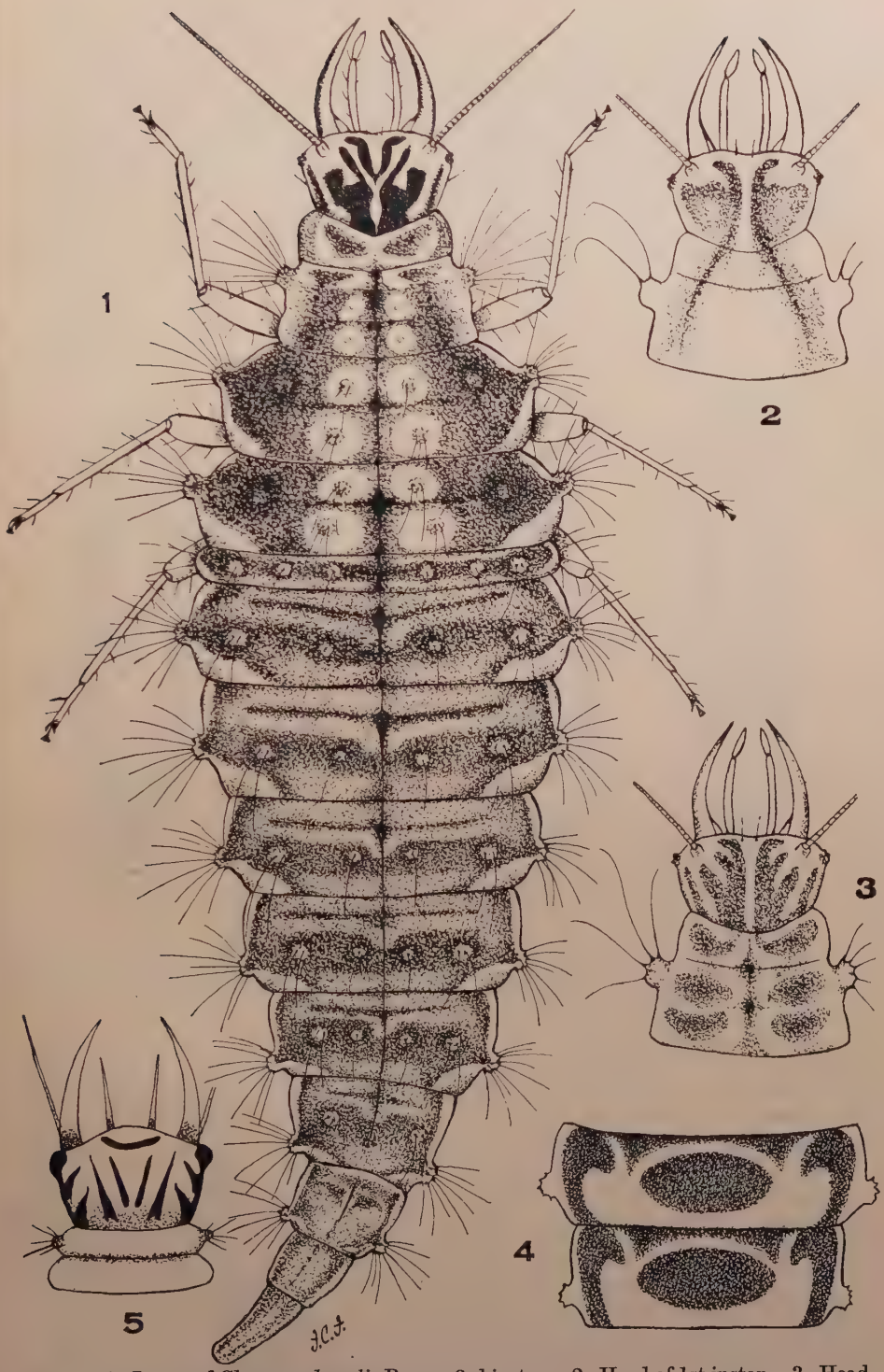

FIG. 1.—1. Larva of *Chrysopa dorsalis* Burm., 3rd instar. 2. Head of 1st instar. 3. Head and prothorax of 2nd instar. 4. Undersurface of 4th and 5th abdominal segments. 5. Head of 3rd instar (after Atmore).

instar, each bears two very long setae which are strongly curled forwards at their apical third or half, later these increase in number, are proportionately shorter and curl posteriorwards for the greater part. The colour rapidly develops with age and just prior to the first ecdysis, becomes a uniform dull carneous, the head markings becoming proportionately darker. The second instar takes on a more definite pattern, the head bears dorsally a dark marking confluent slightly over the occiput and shaped like the human hand with the thumb on the outer side and two fingers, all directed forwards. The middle finger is rather sharply angulated outwards at its apical end and there is an additional blackish line on the outer side of the head which extends

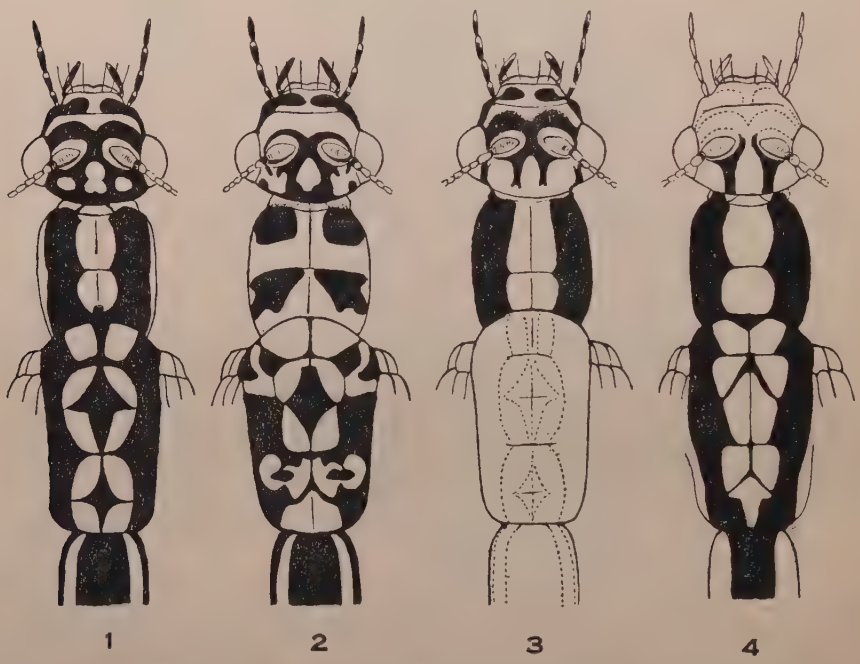

Fig. 2.—Dorsal head and thoracic markings of:—1. *Chrysopa dorsalis* Burm., adult. 2. *Chrysopa perla* (L.). 3. *Chrysopa dorsalis* Burm., after Killington. 4. The same after Atmore. (The markings shown in dotted outline in figs. 3 and 4 are hypothetical and are not shown by the authors.)

forwards as far as the eye. A broad irregular and interrupted fascia extends along the dorsum on each side of the mid line of prothorax and thorax, the two fasciae being separated by a chain of large pallid spots which form areolae around the dorsal tubercles. Laterally each fascia extends wedge-like towards the lateral tubercles so that a clear space is visible anteriorly and posteriorly on each segment, sharply defined against the dark plum colour of the fascia. A chain of small dark spots makes its appearance on the middorsal line, extending nearly to the end of the abdomen; the latter bears a continuation of the dorsal thoracic fasciae but more broken and consisting on each segment of two transverse stripes which converge and become confluent outwardly and a more obscure paler marking on the postero-lateral angle of each segment. The 3rd and last instar is very similar to the 2nd but the fasciae are more

continuous and darken until almost blackish or deep purplish brown. The markings on the dorsum of the thorax are especially black and this colour deepens to form an areola around each medial tubercle; the clear middorsal spaces are paler and much more sharply defined. On the abdomen the two transverse stripes separate, the basal one being dark and linear, the posterior one broad and enclosing the two inner pairs of tubercles. Outwardly, from the mesothorax to as far as 9th abdominal segment, the fasciae now show a deeply serrated outline. The head markings are very constant and characteristic, the inner finger of the dorsal marking usually being separated from the palmar portion but confluent with its fellow posteriorly across the middle line so as to form a well-defined V, the anterior ends of which turn sharply outward. The legs are obscurely pale greyish or darker at the knees, the end of the tarsus black. The ventrum is marked by a medial chain of blackish transversely oval spots each bordered outwardly by hook-shaped spots (fig. 1, 4).

The sequence of events in the life-history of the first specimen to spin up was as follows :—

Ovum deposited : 7th July.
Hatched : 16th July.
Second instar : 20th July.
Third instar : 26th July.
Prepupal state : 12th August.

The cocoon was spun amongst pine needles or in the angle between the wool plug and the wall of the test-tube.

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The Society is prepared to undertake the provision of a reasonable number of text figures. The original drawings for such figures must be supplied by authors. Such drawings or groups of drawings must be drawn to a scale which will permit of their reduction to an area of dimensions not exceeding $7\frac{1}{2} \times 4\frac{3}{4}''$. In the case of the *Proceedings Series A* and *Series B*, authors are required to pay for the necessary blocks for the provision of plates, half-tone and coloured work.

A uniform method is adopted for the citation of bibliographical references in the Society's publications as follows:

Smith, A., 1936, New species of Coccidae. *Proc. R. ent. Soc. Lond.* (B) **6** : 301–306, pl. 1.

——. 1936, New species of Coccidae. *Trans. R. ent. Soc. Lond.* **84** : 901–936.

Titles of periodicals cited are to be abbreviated in the manner indicated in the *World List of Scientific Periodicals, 2nd edition*, 1934.

Authors are entitled to receive 25 copies of their papers free of charge and may purchase additional copies provided that request be made before publication.

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MEETINGS

TO BE HELD IN THE SOCIETY'S ROOMS

41, Queen's Gate, S.W.7

1946.

WEDNESDAY, January 16 (ANNUAL MEETING)
„ February 6

THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON

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